

Announcements

□ Homework for tomorrow...

Ch. 23, CQ 3, Probs. 4, 8, & 9

CQ7: closer together

22.16: 20 mm

22.18: 0.24 mm

22.20: 2.9°

□ Office hours...

MW 10-11 am

TR 9-10 am

F 12-1 pm

□ Tutorial Learning Center (TLC) hours:

MTWR 8-6 pm

F 8-11 am, 2-5 pm

Su 1-5 pm

Chapter 23

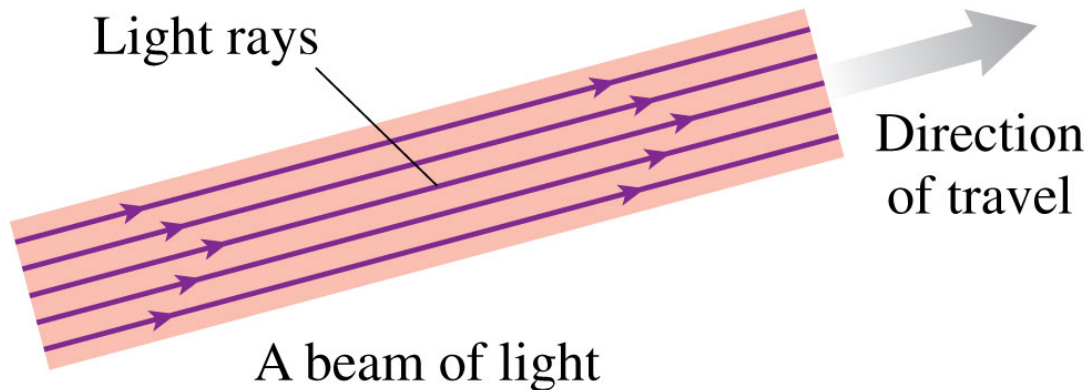
Ray Optics

(The Ray Model of Light & Reflection)

23.1:

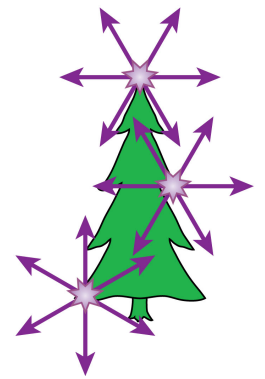
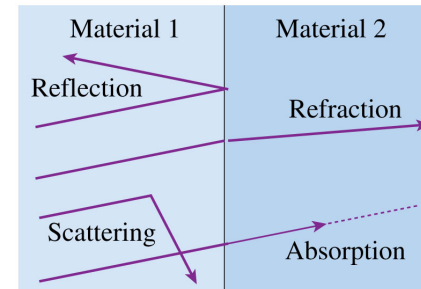
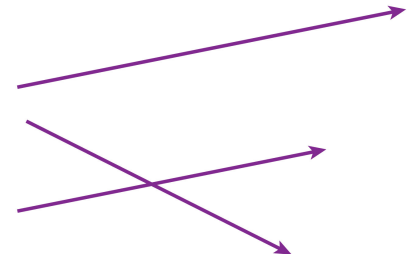
The Ray Model of Light

- The ray model is valid as long as any apertures through which the light passes are *very wide* compared to the wavelength of light.
- Define a light ray as a line in the direction along which *light energy is flowing*.
 - A light ray is an *abstract idea*, not a *physical entity*.



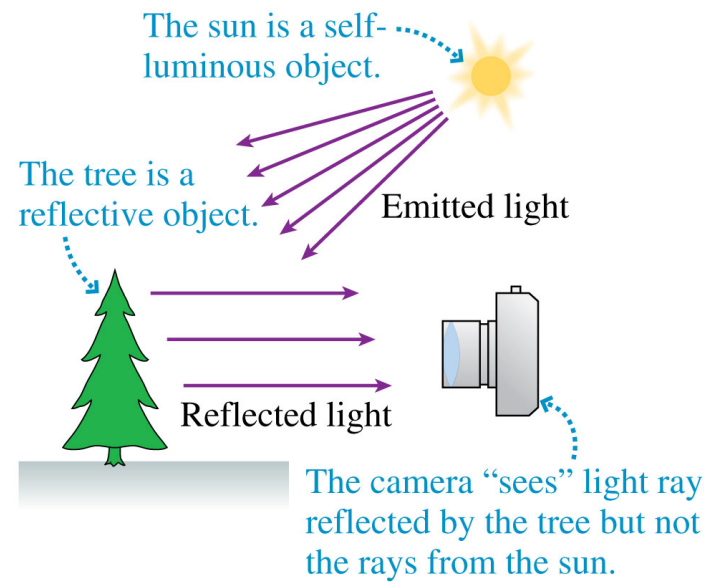
The Ray Model of Light (5 basic ideas)...

1. Light rays travel in straight lines.
 - The speed of light is $v = c/n$, where n is *the index of refraction* of the material.
2. Light rays can cross.
 - Light rays do *not* interact with each other.
3. A light ray travels forever *unless* it interacts with matter.
 - Light interacts with matter *four* ways:
 1. Either *reflected* or *refracted* at an interface.
 2. Either *scattered* or *absorbed* within a material.
4. An object is a source of light rays.
 - Rays originate from *every* point on the object and sends rays in *all* directions.
5. The eye sees by focusing a diverging bundle of rays.



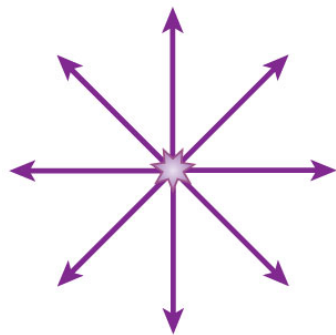
Objects...

- Objects can be either *self-luminous* (i.e.: sun, flames, and light bulbs) or *reflective*.
- Most objects are *reflective*.



Objects...

- The diverging rays from a *point source* are emitted in all directions.
- Each point on an object is a point source of light rays.
- A *parallel bundle* of rays could be a laser beam, or light from a *distant object*.



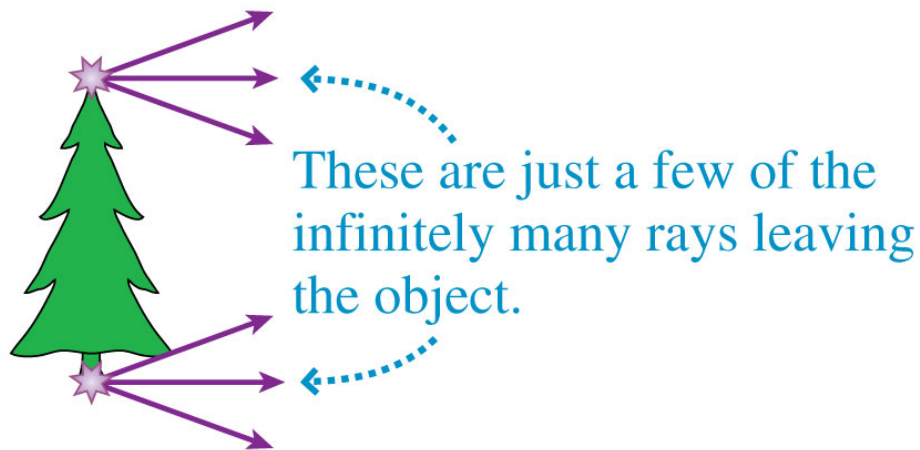
Point source



Parallel bundle

Ray Diagrams...

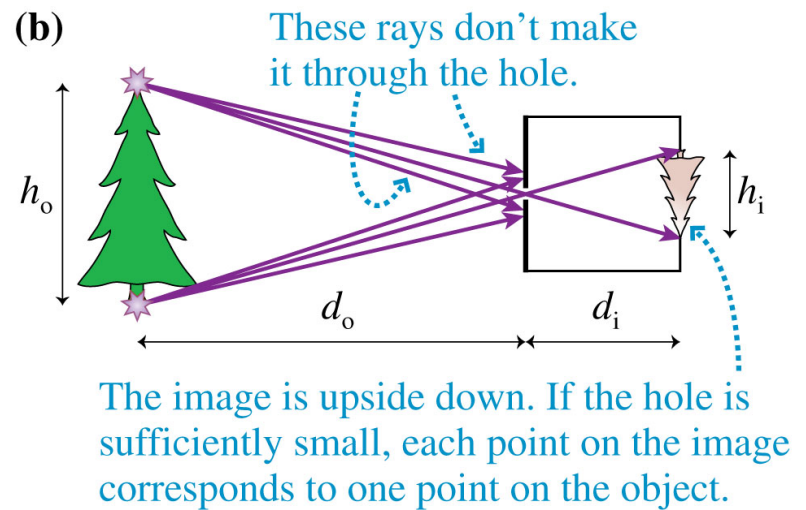
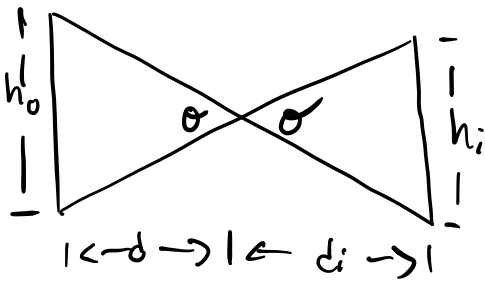
- Rays originate from *every* point on an object and travel outward in *all* directions, but a diagram trying to show all these rays would be messy and confusing.
- To simplify the picture, we use a *ray diagram* showing only a few rays.



Apertures...

Consider passing light through a *small aperture*...

- The *geometry* of the rays causes the image to be *upside down*.
- The object and image heights are related by:



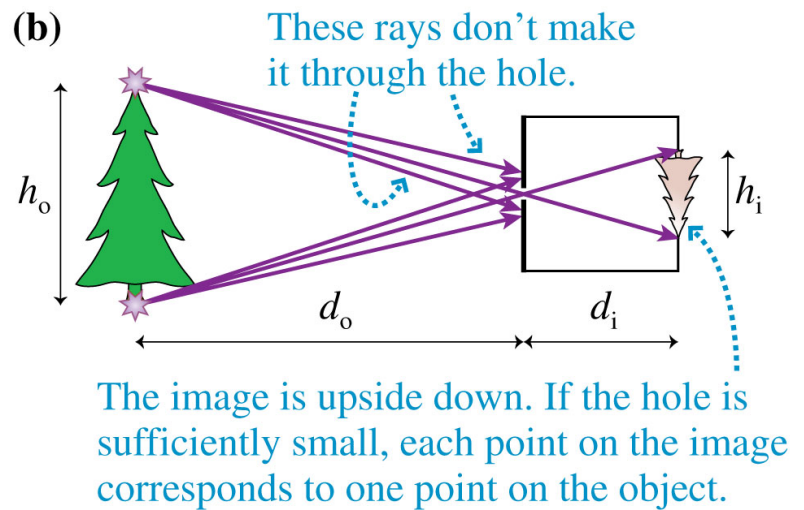
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Apertures...

Consider passing light through a *small aperture*...

- The *geometry* of the rays causes the image to be *upside down*.
- The object and image heights are related by:

$$\frac{h_i}{h_o} = \frac{d_i}{d_o}$$



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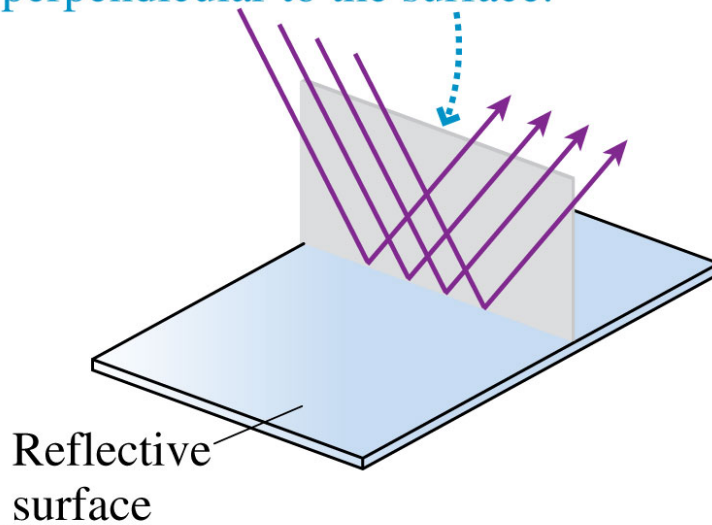
23.2

Reflection

Specular Reflection...

- ▣ reflection from a flat, smooth surface, such as a mirror or a piece of polished metal.

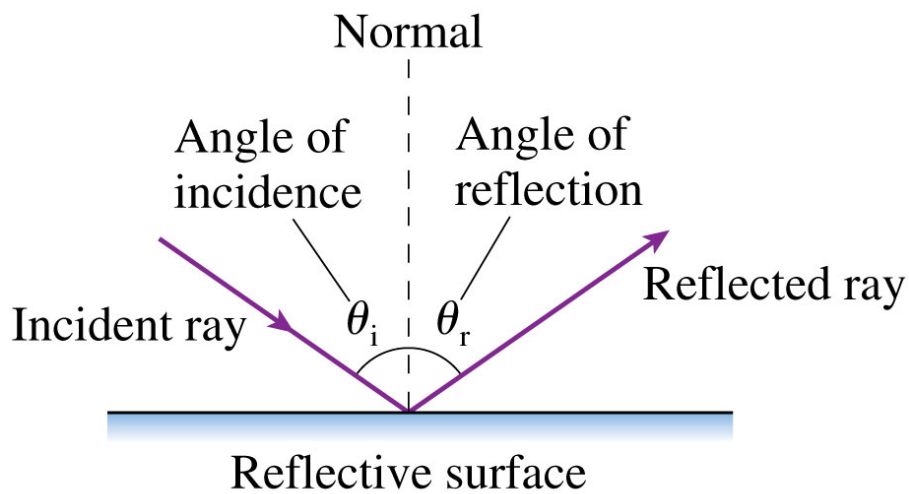
The incident and reflected rays lie in the plane of incidence, a plane perpendicular to the surface.



Law of Reflection..

1. The *incident* and *reflected ray* are in the same plane normal to the surface.
2. The angle of reflection equals the angle of incidence:

$$\theta_i = \theta_r$$

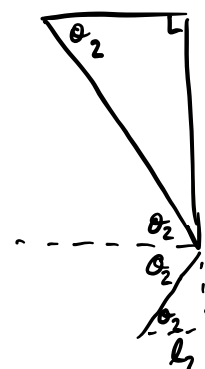
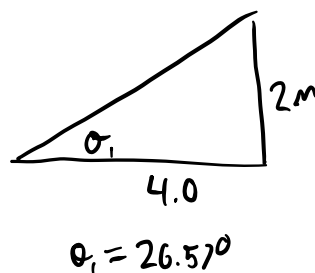
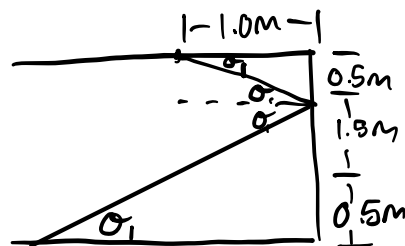
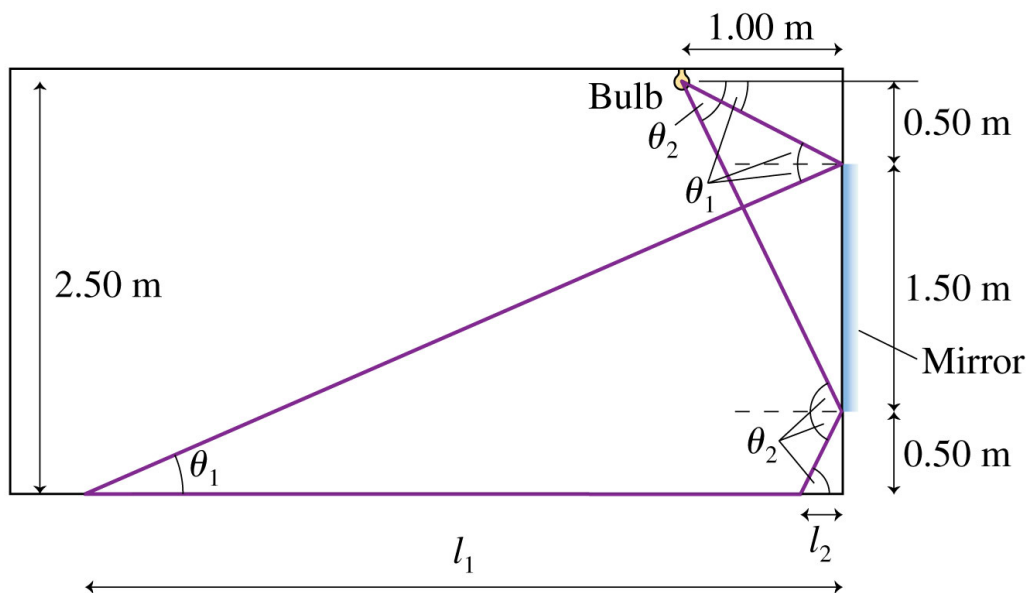


i.e. 23.1:

Light reflecting from a mirror

A dressing mirror on a closet door is 1.50 m tall. The bottom is 0.50 m above the floor. A bare light bulb hangs 1.00 m from the closet door, 2.50 m above the floor.

How long is the streak of reflected light across the floor?



$$\tan\left(\frac{\theta}{2}\right)$$

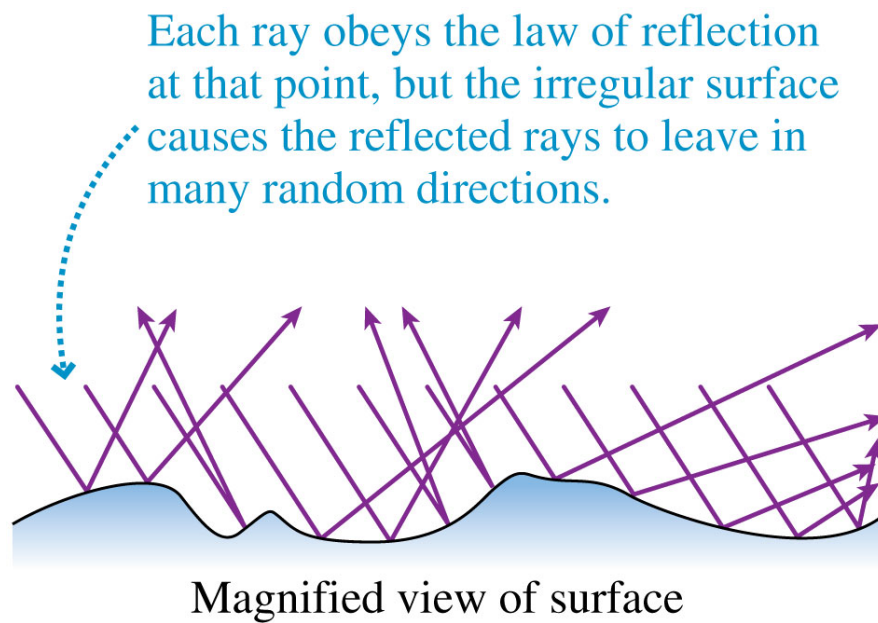
$$A \tan \theta = 0$$

$$A = \frac{0}{\tan \theta}$$

$$l_2 = 0.25$$

Diffuse Reflection...

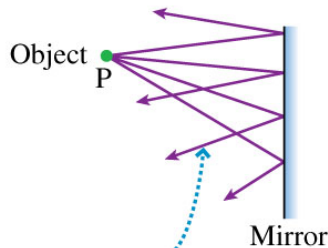
The *Law of Reflection* is obeyed at *each point* but the irregularities of the surface cause the reflected rays to leave in many directions.



The Plane Mirror...

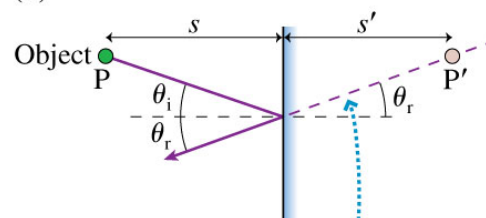
- Consider a source of rays from point P , which reflect from a mirror...
- The reflected rays *appear* to emanate from P' , which is the *same distance* behind the mirror as P is in front of the mirror ($s = s'$)

(a)



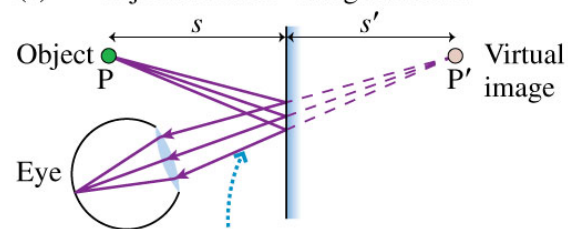
Rays from P reflect from the mirror. Each ray obeys the law of reflection.

(b)



This reflected ray appears to have been traveling along a line that passed through point P' .

(c) Object distance Image distance

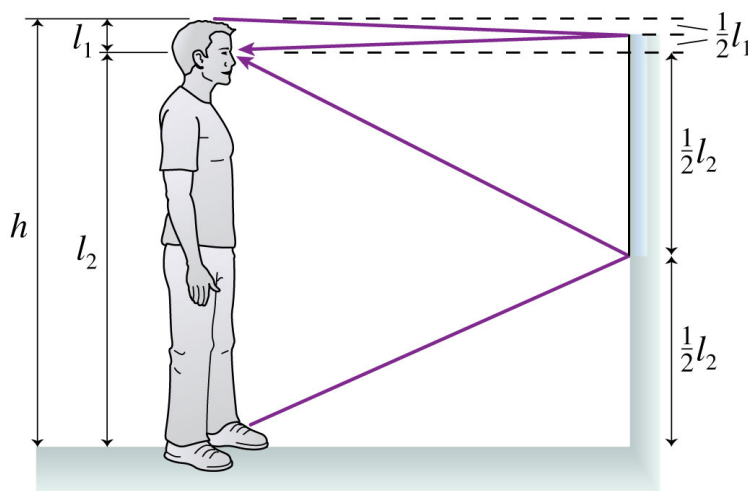


The reflected rays *all* diverge from P' , which appears to be the source of the reflected rays. Your eye collects the bundle of diverging rays and "sees" the light coming from P' .

i.e. 23.2:

How high is the mirror?

If your height is h , what is the shortest mirror on the wall in which you can see your full image? Where must the top of the mirror be hung?



$$h = l_1 + l_2$$

$$h - \frac{l_1}{2} - \frac{l_2}{2} = h - \frac{1}{2}(l_1 + l_2) = h - \frac{h}{2} = \frac{h}{2}$$

$$H = \frac{h}{2}$$